

# Hot Iron

Issue 33

"Journal of the Constructors Club"

Autumn 2001



## Editorial

I should be harvesting now but it is raining fairly steadily and that will keep the combine in the shed for 2 days at least so I had better start on this issue, the first Hot Iron of the new subscription year. Many thanks to all of you regulars who have renewed for several years now. Days like this are good for pondering new ideas for kits or projects but increasingly I find that designing down to a price bracket is impairing what I think is good value for money. In real terms, the price of factory made kit is lower than ever, and it makes it unattractive to spend say half the cost of a new 100 Watt all band rig on a well equipped upmarket kit - but this doesn't acknowledge the real pleasure of operating home built gear! Hoping that price is not everything for my customers I shall not attempt to duplicate the very simple and low performance designs that appear from time to time. As in most walks of life, you get what you pay for! For kits, the basic hardware and PCB - even in my 'open' style of construction - usually account for well over half the costs so adding a few extra parts or stages only increases the price by a smallish amount. I know that many builders have great pleasure from using extremely simple rigs

but seldom can they seriously compete under difficult conditions so I think my efforts should be directed further up the complexity scale while still pursuing performance for cost considerations. Do please tell me what you think and what you would like to build which is not currently available from any supplier. I have great difficulty deciding what sort of rigs are best/wanted in this middle ground!

## Kit Developments

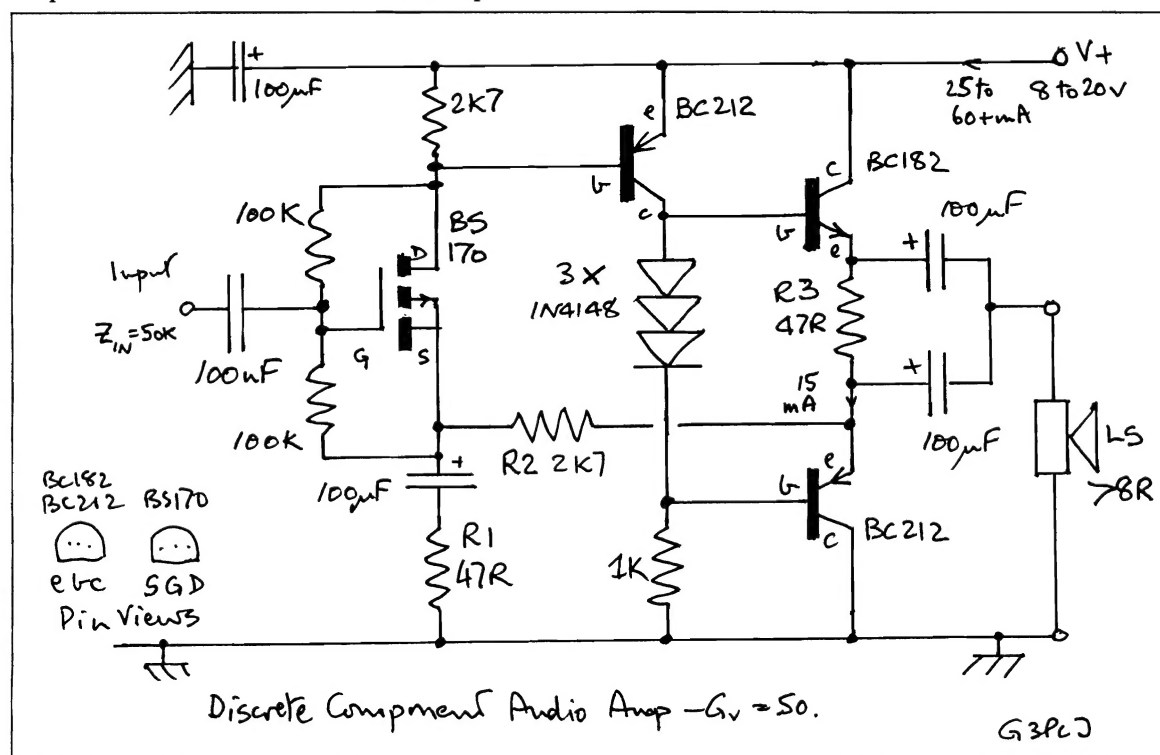
The first **Highbridge** CW TCVR is now working well but has needed extensive modifications to get the mixer and ceramic resonator VFO right. It is designed for 80m in its simplest form but, with a mixer kit for the VFO, it should perform equally well up to 20m. It runs on 8 volts upwards, with good sensitivity, so is suitable for /P operation and produces 5 Watts on 13.8 volts. It has full break-in operation, low pass RF filters, sidetone etc.. The main audio filters are bandpass fifth order centred on 750 Hz for CW, with output for phones or LS. It has Polyvaricon tuning of the ceramic resonator pullable VFO; the prototype will cover all of the CW section but that makes tuning very critical so it is usually restricted to near 3.56 MHz. The kit includes all parts for the 'small open style format'. I have altered the track masters and text so would like to have a few early builders. Anyone interested? Normal price will be £44 but only £39 (plus £1 P & P) for the early birds!

Other projects being considered are a 20, 40, 80m regen TRF and matching 1.5 Watt CW TX and an improved single band DC RX. What about DSB phone transmitters? Tim Walford. G3PCJ

*Hot Iron* is a quarterly newsletter for radio amateurs interested in building equipment. It is published by Tim Walford G3PCJ for members of the **Construction Club**. Articles on simple theory, construction, testing, updates on kits, questions and suggested topics are always wanted. Please send correspondence and membership inquiries to Upton Bridge Farm, Long Sutton, Langport, Somerset, TA10 9NJ. Tel 01458 241224 or e mail [walfor@globalnet.co.uk](mailto:walfor@globalnet.co.uk) The Walford Electronics website can be seen at [www.users.globalnet.co.uk/~walfor](http://www.users.globalnet.co.uk/~walfor) The Copyright of all material published in Hot Iron is retained by TRN Walford. ©. Subscriptions are £6 per year for the UK (£8 overseas) from Sept 1st in each year.

### ***Discrete Loud Speaker Driver***

A future project needs an output stage capable of driving a loud speaker but to be in keeping with the rest of the rig, it has to avoid using an IC. The traditional approach is to use a transformer to drive the low loud speaker impedance from the relatively high output impedance of an amplifying stage - but they are expensive, bulky and difficult to mount! A Class A design would draw an undesired heavy standing current so it has to be two output transistors operating in nearly Class B. Often an audio amplifier is arranged as a low level voltage amplifying stage(s) driving a 'unity voltage gain 'totem-pole' emitter follower output stage consisting of a pair of npn and pnp devices working in near Class B. A small standing current through these devices reduces cross-over distortion, which occurs during the signal 'zero-crossing' when one polarity of device takes over supplying the load current from the other polarity device - it is also dependent on their finite base to emitter voltage. The higher the standing current, the less the cross-over distortion because the stage is increasingly acting in Class A where ultimately the standing current would be at least as large as the peak signal current. Apart from flattening the battery more quickly, a high standing current will require bigger (expensive) devices and heatsinks (even more expensive!); thermal runaway also needs consideration to prevent the heat changing the bias conditions in a manner which increases the dissipation! The usual arrangement for setting this small standing current through the output devices is an extra 'V<sub>be</sub>' multiplying transistor and a preset at their bases. Instead I have used three silicon diodes to set the voltage between the bases of the output transistors so that a single resistor between their emitters can define the current. Two capacitors then couple out to the load. The rest of the scheme (below) uses a MOSFET input stage for high input impedance and easier biasing. This drives the second voltage amplifying pnp stage. The whole is enveloped in negative feedback to stabilise the DC operating conditions and determine overall voltage gain. It is insensitive to changes in supply voltage between 8 and 20. The centre of the 'totem-pole' settles at about 5 volts below the supply voltage. The open loop voltage gain is over 500 but the closed loop gain (as drawn) is reduced to about 50 (determined by the ratio of R<sub>2</sub> divided by R<sub>1</sub>) to help minimise distortion etc. It produces 0.2 Watts RMS into 8 Ohms on 13.8 volts drawing 60 mAmps without any heatsinks which is enough for most applications. No signal supply current is about 25 mAmps. For medium impedance series connected walkman type phone use, R<sub>3</sub> can be doubled for a saving of about 7 mAmps. Halving R<sub>3</sub> will increase no signal supply current to about 35 mAmps but with less distortion at full output. Its cheaper than a LM380 with its associated components but it does use more board space! G3PCJ



## Spares!

Don't hesitate to ask if you need any spares; I have them for nearly all rigs ever sold! Payment is easiest by first class stamps for small orders. Please let me know your needs - preferably by e mail.

## Bristol Updates

### Drift on transmit

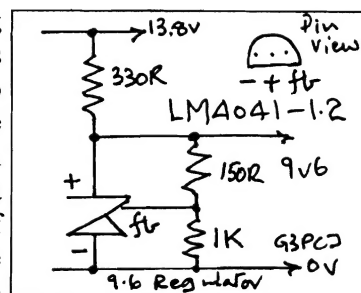
Tests have now pinned this down to warming of the 317 regulator by the heatsink in those rigs where there is inadequate cooling or lack of insulation between them. I have also tried out using a temperature compensated reference diode successfully. Circuit alongside. You can either add this circuit or even repeat the existing 9v6 regulator using another 317L located in a cooler spot. The easiest things to do if you wish to include either of these modifications, is to leave the rig PCB unchanged and feed the main tuning control alone from this new supply instead of from the rig's 9.6 volts. I have some of the reference chips (or extra 317Ls) at 50p plus 50p postage in stamps.

**Supply range** A reluctance to work properly on over 15 volts on transmit is due to restricted bias conditions around TR306/7/8. I regret there is no easy cure except to stick to under 14.5 volts! If you wish to reduce the *minimum* voltage that the rig will work on, place 10K in parallel with R122.

**Birdies!** Page 12 of the Manual mentions the birdy from the SCF clock, experience suggests that a little careful shielding of the clock generator chip IC110 helps - try a little insulated foil.

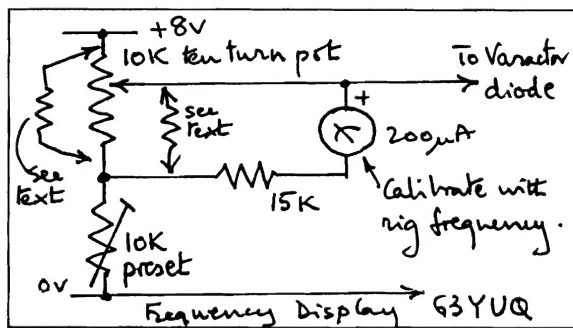
**AGC time constant** If you wish the hold, or hang time, to be a little longer so that the AGC pumps less aggressively between gaps in sentences, you can try doubling C110 to say 22  $\mu$ F.

**Use on 6m!** Andy Howgate has had his on 6m with a special band card. RX was all right (I think!) but RF output was low - as expected. Not sure how low but my guess is about a Watt output! More tests are planned later. G3PCJ



### Single Control Varicap Tuning Display

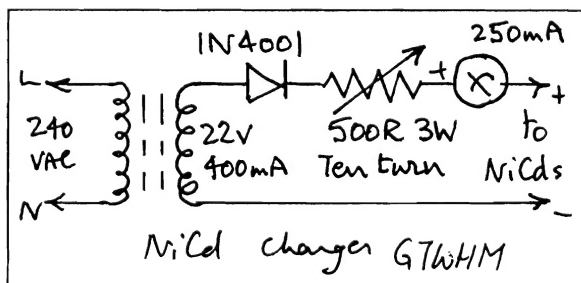
This scheme has been forwarded by Eric Elsley G3YUQ who devised it for his Bruton but it could be used on any Somerset Range rig with varactor tuning. He has changed the Coarse tuning pot for a ten turn type, without any Fine pot, so had to devise a means of showing frequency. He did this quite easily with a sensitive moving coil meter and appropriate resistors. The meter is calibrated afterwards and should not be less than about 200



micro-amps with a series resistor of about 15K to avoid seriously loading the 10K ten turn pot. A lower value will work but it will upset the frequency calibration more. For the LF VFO end, the meter will always read zero; for the HF end the meter series resistor can be adjusted (perhaps with a preset) to give full scale. Eric restricted the band coverage by placing an extra resistor across the ten turn pot - an alternative approach is the tune the associated VFO TOKO core for the VFO HF end, with the ten turn pot set for its most positive output, and then crank the 10 turn pot to the LF negative end and adjust the VFO LF end with the 10K preset. Adjust the meter series resistor to give FSD at the HF end and calibrate the meter using a counter measuring rig transmit frequency. The settings will be interdependent so there is a little trial and error required. You can add a resistor from the pot slider to its negative end, to shift the VFO central section down in frequency without affecting the end stops.

### Charging Nickel Cadmium cells

Andy Howgate found out the hard way that the cheap NiCd chargers that come with many products from radios to power tools leave much to be desired. The most common fault is that they charge far too quickly and cook the cells. He suggests that you break open one of the larger 13 Amp plug type chargers and salvage the transformer, then couple it to just three other parts! The ten turn pot does need to be rated at 3 watts or more and the meter is essential for setting the charging current. He used a cheap multi-meter mounted on a box containing the transformer, pot and rectifier. The important point is that the charging current in Amps should be one tenth of the cell(s) amp-hour rating. If everything were ideal it would be charged in 10 hours, however because there are losses, you should increase the charge current or time by 10% to make sure they are fully charged. This scheme will work with either single or multiple cell battery packs. Its a good habit to set the resistor high after each charge to prevent damage on the next cell!

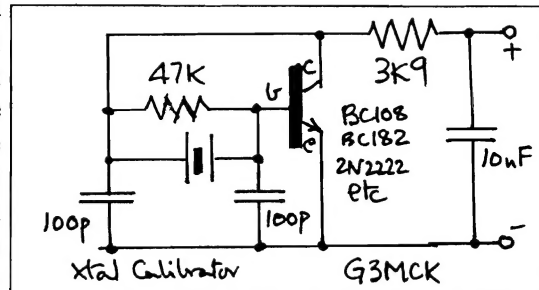


### **A trivial project to encourage very new constructors!**

(I am delighted to welcome Gerald Stancey, G3MCK, as a new contributor - he warned me that this article would be too simple but I think it is just right! Ed)

This project is trivial but useful. It does not take much skill, time, or money so it is a good thing for the novice constructor to cut his teeth on. Please note that when I say his, I also mean her as I believe lady amateurs are honorary chaps. If that upsets you that is your problem not mine. PC does not exist in my QTH, the XYL doesn't allow it.

Now back to radio which is where we started. Anyone who plays about with receivers has the need for some sort of signal generator. Such a device will tell you that the receiver is working, that it is receiving on a particular frequency and it also gives you some idea of how well the receiver is working. Signal generators come in many shapes and sizes varying from the ridiculous to the sublime. This project falls into the first category. The circuit diagram right shows a simple oscillator that can be run from a 9 volt battery or a 13.8 volt PSU. You can build it in any way you want, from ugly construction to perf board. Etched PCB is far too complex but veroboard is a good bet. The choice is yours.



There are no hard to find bits. Crystals can either be bought for the job, the QRP frequencies are readily available or for the more financially challenged, the colour TV crystals on 3579.4 KHz can often be yours for the asking. At most rallies it is possible to buy crystals for pence. These may appear to be useless frequencies but a handful of non-amateur frequencies can be helpful when making general coverage receivers. Also near and non-favoured frequencies in the amateur bands can sometimes be found; for example at the Yeovil QRP Convention I bought a 3596 KHz crystal, in the band but not much use for transmitting and a 3484 KHz crystal, which is OK for setting the low band edge of a receiver.

Just wire up the oscillator, apply power and drape a bit of wire from the receiver aerial terminal over the unit. When the receiver is tuned to the appropriate frequency, you will hear a loud clear signal. The signal strength depends on how tightly you couple the receiver to the oscillator. Check the strength on a known receiver, then substitute your home brew receiver and see how it compares for gain. This is a bit iffy but at least it does give you some idea.

Next issue, we will look at boxing the unit, getting consistent output and attenuators, all simple kitchen table stuff and no maths.

Gerald G3MCK

#### Post article note!

Member David Proctor G0UTF has asked about inductance and capacitance values to pull crystals; since I think this follows on from Gerald's note I have asked him to address this topic at some time in the future.

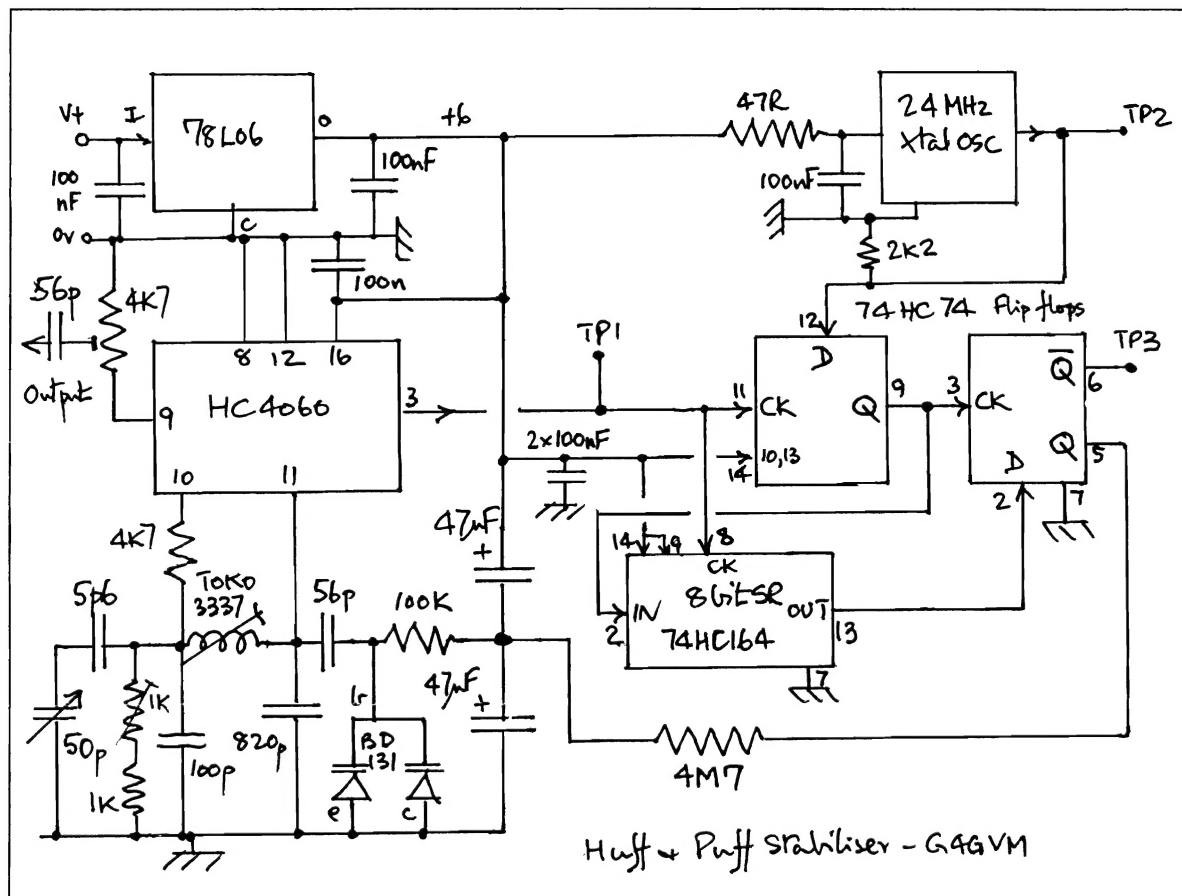
In the meantime, I offer the practical comment that *ceramic resonators* can be pulled very much farther in frequency than crystals due to their lower Q - in thousands as opposed to perhaps up to 100,000 for a good crystal. Most common ceramic resonators, such as those for 3582 KHz are designed for a 30 pF parallel load capacitance from the rest of the circuit. Increasing this capacitance can pull them a long way down! They have a wide initial tolerance (0.5%) but will often go down to 3500 KHz with around 150 pF across them. They are very cheap and great for experimenting - they will work in the above circuit! Their drawback is relatively poor temperature stability. This effect gets worse as the operating frequency increases - however they are quite useable for most purposes on 80m with shortish QSOs and the necessity to retune from time to time to find new stations.

### **Mixer kit**

An interesting possibility arising from the above is to use a 4 MHz ceramic resonator VXO, mixed with a 11 or 18 MHz crystal to provide a LO output for a DC rig on 40 or 20m. I have laid out a versatile new **Mixer** kit to do just this - it has many advantages over a VFO running at transmit frequency because it prohibits chirp and is likely to be much more stable. The design also allows for it to act as a *receiving converter* for one or two bands under relay control. If the same crystal can be used for both bands, eg. 20 and 40m converted to 80m, then not even the relay is required! The flexibility is achieved by permitting the double tuned RF bandpass filters to be connected either, in front of the mixer for a converter, or after it for a mixing VFO scheme. Size is 53 x 100 mm, supply 8 to 18 volts.

## **Huff and Puff Frequency Stabiliser** by Derek Alexander G4GVM

The name derives from the operating sounds made by the constant speed governor system used on steam engines in Victorian textile factories. Decreasing shaft speed caused the governor to open the steam valve more so increasing speed and vice-versa. This form of negative feedback is applied to the VFO frequency control voltage by a device which assesses changes in frequency by comparing it with a crystal based reference frequency. The idea was first suggested by Klaas Spaargaren PA0KSB in 1973 but has since been simplified, notably by Charles Fletcher G3DXZ, who has published notes in RadCom from 1996 onwards. It is still developing and the circuit below is my latest version. As a matter of principle, I use a dedicated 6 volt regulator to feed this system.



**VFO & Divider chain** Most chips with built in oscillators are for crystals rather than for VFOs; the 4060 can use either or you can use its oscillator gate as a buffer driven from an external VFO. I have been unable to make varactor main tuning work so I use an air variable capacitor with a 3337 TOKO coil for a nominal 5 to 5.5 MHz VFO. The 4060 has a divider chain arranged to produce the A output (TP1) at about 300 Hz for mid VFO frequency. Extra dividers are needed for higher frequency VFOs.

**Crystal Ref Oscillator** The other input component is the crystal frequency reference B (TP2) against which the VFO is compared. The reference frequency should be as high as possible (over 20 MHz) and is most easily provided by a crystal oscillator IC. They need 5 volts so a supply dropper is used.

**Comparator** This uses a HC7474 dual D flip-flop and a HC164 shift register. The A divider output is fed to the clock input of the first flip-flop and that of the shift register. The first flip-flop Q output feeds the clock input of the second flip-flop and the serial input of the shift register. The delayed output of the shift register feeds the D input of the second flip-flop whose Q output feeds the integrator via 4M7. The Q bar output (TP3) has a frequency which jumps around from 0 to 20 Hz.

**Integrator** The integrator 'capacitor' stores the mean voltage controlling the capacitance of the varactor diode; the voltage is nudged up or down by the pattern of pulses from comparator circuit. Two capacitors are actually used so that at switch on, the control voltage rises automatically to mid supply. Using a 6 volt supply provides a larger maximum control or capacitance range for dealing with drift in the VFO. An effective substitute for rare varactors like the BB212 is to use a reverse connected BD131. The desired scaling is about 4 KHz per volt giving 12 KHz either side of the starting point. This can be adjusted by varying the value of the small capacitor linking to the VFO from the varactor.



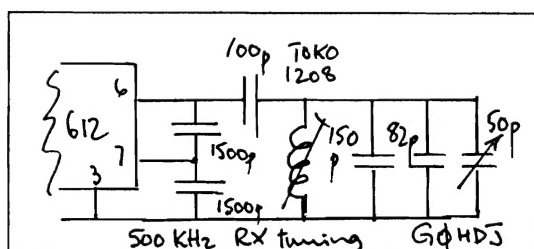
*Notes - pros and cons* The accuracy is astounding. On mine, for 10 minutes after switch on it drifts some 6 or 7 Hz, then not at all in the next 6 hours before I stopped measuring! At switch on, the frequency will be within a couple of KHz of that at the previous close down, due to drift correction during the previous use. The system locks up at intervals of 10 Hz and cannot be set in between. This is quite good enough for copying SSB. The interval is dependent on the frequency of the reference oscillator; the interval can be reduced by using a higher crystal reference up to 40 MHz maximum when loop instability problems arise. The test point values are not rigid but give a good guide as to what to expect.

You can use IC holders which eases the layout and facilitates changing chips. I have done a track layout etc. which is available from me. Best of luck, Derek!

### 500 KHz Receiver Tuning Range

Craig Douglas G0HDJ has found that a reduced VFO range is desirable for the receiver that he outlined in the last Hot Iron. The revised circuit is alongside and now covers 485 to 520 KHz. He has yet to hear any CQD calls!

Craig also asks about coupled resonant circuits, so here follows a little light maths!



### Coupled Resonant Circuits

Two resonant circuits, usually in the parallel format, can be coupled by either a 'top' capacity between the hot ends of the resonators or a 'bottom' inductor between the two inductors as shown right. The size of the coupling components is determined by the desired bandwidth for the circuit. The bandwidth  $B_w$  is defined as the difference in frequency between the points where the response is 3 dB down. The resonant frequency  $F_0$  of each resonator is given by the familiar formula:-

$$F_0 = \frac{1}{2\pi\sqrt{LC}}$$

The loaded Q of the whole circuit is then:-

$$Q_L = F_0/B_w$$

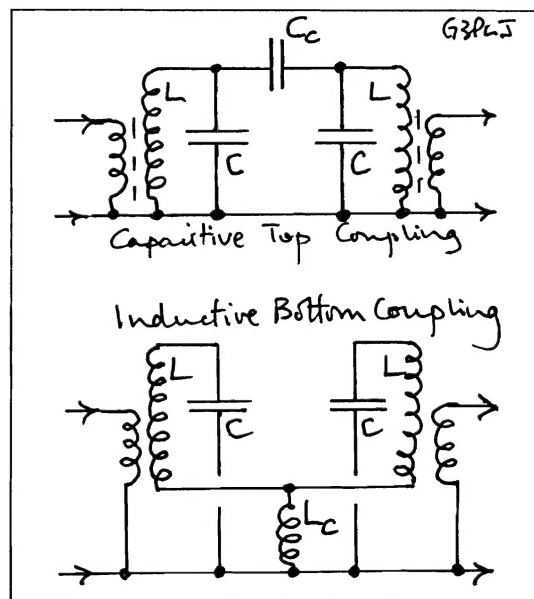
For an identical pair of capacitively top coupled resonators, the small coupling capacitor required to achieve this Q is related to the resonating capacitor by:-

$$C_c = C/\sqrt{2}Q_L$$

Similarly for bottom coupled resonators, the small coupling inductor is related to the main inductors by:-

$$L_c = L/\sqrt{2}Q_L$$

As a very rough rule of thumb, for most amateur band use, these coupling components should be about one twentieth of the either the resonating capacitor or inductor. The circuits above have been drawn for inductive link input and output connections; they could alternatively be done by either capacitive or inductive tapping but in all cases the source or load impedance of the outside circuits must not seriously load or degrade the Q of each resonator. (This is all actually a bit simplistic but is a good basis for experimentation!) G3PCJ



Finally, I must apologise for this issue coming out a little late - its been poor harvesting weather!